

## Project Update : July 2022



Ebo forest

### **INTRODUCTION**

Bat populations around the world are threatened and declining through habitat loss, emerging diseases, pollution, destruction of shelters and persecution due to human activities (Aguirre et al. 2016; Kingston, 2016). They constitute the second most diverse group of mammals behind rodents with up to 1400 species (Simmons and Cirranello, 2021). Bats are the critical elements of biotic community functioning and they contribute significant ecological functions, such as pollination, insect predation, and seed dispersal (Kunz et al. 2011; Moosman et al. 2012; Maas et al. 2016). The recent reductions of many bat populations as a result of human activities have increasingly concerned conservation biologists (Kingston, 2010; Voigt and Kingston 2016). Over the past decades, the emergence of zoonotic viruses (those that are naturally transmitted between vertebrate animals and humans) from bats have been the subject of increasing attention from both scientists and the general public (Quammen, 2013). Identification of bats as natural hosts for emerging viruses has important implications for bat conservation (Maurice et al. 2017). Programmes directed at bat conservation worldwide recognise that it's necessary to understand the diversity of local knowledge

systems and the variety of views in order to improve conservation and education strategies (Kingston, 2016).

In Cameroon, studies on this group benefited a real interest regarding many studies that have been made in several areas. Studies addressing the involvement of bats regarding the social dimension in rural communities are still scarce showing a significant lack of data to contribute to an effective bat conservation strategy. Only some studies took place in the North West and South West regions of Cameroon focused on bat consumption, disease transmission and conservation (Eboa et al. 2011; Maurice et al. 2017; Baudel et al. 2019 ; Akem and Pemunta 2020). This type of work was not previously reported in Littoral region showing a real interest to contribute to our overall knowledge of national bat biodiversity. Indeed, data from less studied areas such as Ebo are needed. Located in the Douala-Yabassi area Ebo forest have a biogeographic and conservation interest. Indeed, this forest represents the most important tract of intact forest landscape in the Cross-Sanaga-Bioko coastal forest ecoregion (Potapov et al. 2017). It consists of a series of steep with rocky outcrops and is home to many threatened species of vertebrates including mammals (Morgan et al. 2003; Oates, 2011), birds and amphibians (Dahmen, 2013; Whytock et al. 2018), having a high conservation importance according to the IUCN Red List. Despite its high diversity, Ebo forest is under several threats including habitat loss, agriculture, logging and hunting (Morgan et al. 2013; Mahmoud et al. 2020). According to our preliminary work in 2017, it's one of the main sites in the country that supplies local markets of Douala, Yaoundé and Edéa with bushmeat. Following our observations and those collected from local people in our previous pilot fieldwork, Ebo forest also hosts a huge cave (Bikombi cave) used by bats as a reproductive and roosting site and where a permanent contact with bats has been proven. This cave is subject of critical threat such as the hunting for local consumption and others uses increasing conflict with bats. Conservation efforts and educational actions are needed to minimise the contact with bats in Ebo forest and prevent a zoonotic transmission eventually.

### **Main goal**

The aim of this study was to assess the bats diversity in Ebo Forest (Littoral region-Cameroon) in order to identify species having a conservation importance and those involved in zoonotic transmission.

### **Specifically to :**

- Evaluate the perceptions, attitudes and practices of peoples living in and surrounding the Ebo forest towards bats (to highlight the general knowledge, myths, threats, conservation and risks of zoonotic transmission).
- Make an taxonomic clarification of species combining morphological and molecular approaches.
- Compare the bat species richness, composition and species abundance between habitat types (primary forest, secondary forest, cocoa farm and surrounded human settlement).

## **METHODOLOGY**

### **1- Project site**

Ebo Forest in the Littoral region of Cameroon (10°25'58"N, 4°30'15"E and 10°11'15"N, 4°6'39"E), is located between the Nkam and Sanaga-Maritime Departments (Figure 1)

and characterised by a very high diversity of animals and plant species, including several endemic taxa. It covers area near of 1400 km<sup>2</sup> and represents the most important tract of intact forest landscape in the Cross-Sanaga-Bioko coastal forest ecoregion (Potapov et al. 2017). The forest takes its name from the Ebo'o river which crosses its middle from north to south. It is bounded on the west by the "Dibamba" river and the east by the "Iwouem" river, which flows into the "Sanaga" river. The forest is characterised by two climatic seasons: a dry and a rainy season with May to September considered as the wet season (Whytock, 2021). However, it rains all year-round with annual rainfall ranging from 2300 to 3100 mm per year (Abwe, 2019). The average annual temperature is range from 25 to 28°C while the average relative humidity is 86 %.

The forest is a complex mix of high-canopy, secondary lowland and sub-montane forests ranging in elevations from 200 to 1200 m asl (Whytock, 2021). It comprises different habitat types including closed canopy forest, open canopy forest, disturbed forest, swampy areas, and former village sites where small oil palm (*Elaeis guineensis*) and cocoa (*Theobroma cacao*) plantations still exist. There are also some small areas where certain species of fruit trees are abundant, such as the *Coula edulis* (hazel tree) in the northwestern part of the forest. Despite his special landscape, some portions of the forest have been logged by forestry companies. Indeed, since March 2020 the government announced that two long-term logging concessions were to replace the proposed national park. The protests efforts from local communities, and NGOs has conducted the government to suspend concession decree. Following Whytock et al. 2021, various stakeholders are now proposing an inclusive and transparent local use planning process for the forest safeguard its rich diversity and to sustainably cater for the needs of surroundings communities. The human population in and around the Ebo Forest is distributed in the villages of Yingui, Yabassi and Massock Song-loulou, districts of the Nkam and Sanaga Maritime departments respectively. These villages at the edge forest practice farming and hunting. There is also illegal bark and woodsharvesting. The main ethnic groups are the Banen in the north and south-east, and the Bassa in the west, south-east and east.

### **Field work**

Between February and May 2021, we conducted a survey with local peoples living in Iboti, Lognanga, Logdeng and Ndogbanguengue, villages surrounding the northern part of Ebo (figure 2). These villages were chosed because the hunting and consumption of bat meat are frequent as well as their proximity and their accessibility to the Bikombi cave, the main location and destination for hunters. We prepared a semi-structured questionnaire (opened and closed questions) in French and visited first the local administration to explain the research activity before data collection. Participants were randomly selected and each volunteers confirms a consent before the interview started. During interviews, a local translator helped for some interviewee like old men who only speak Bassa or Banen, the native languages in our sites.

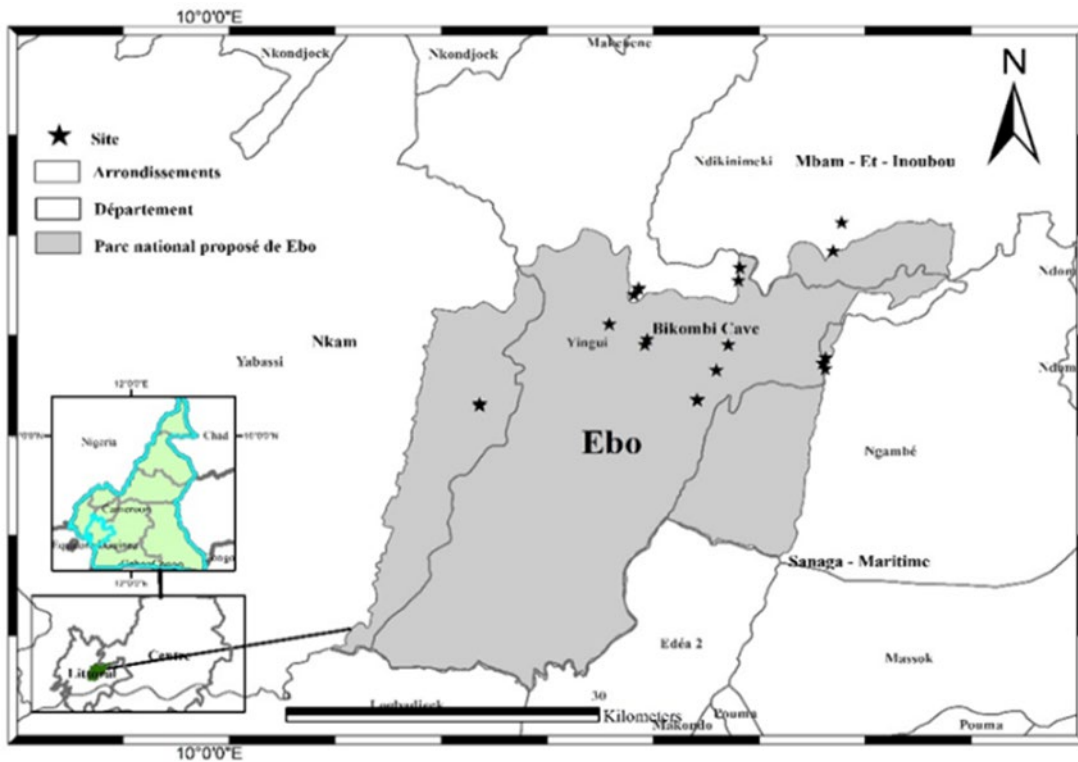


Figure 1 : Map of Ebo forest showing the bats samplings sites.

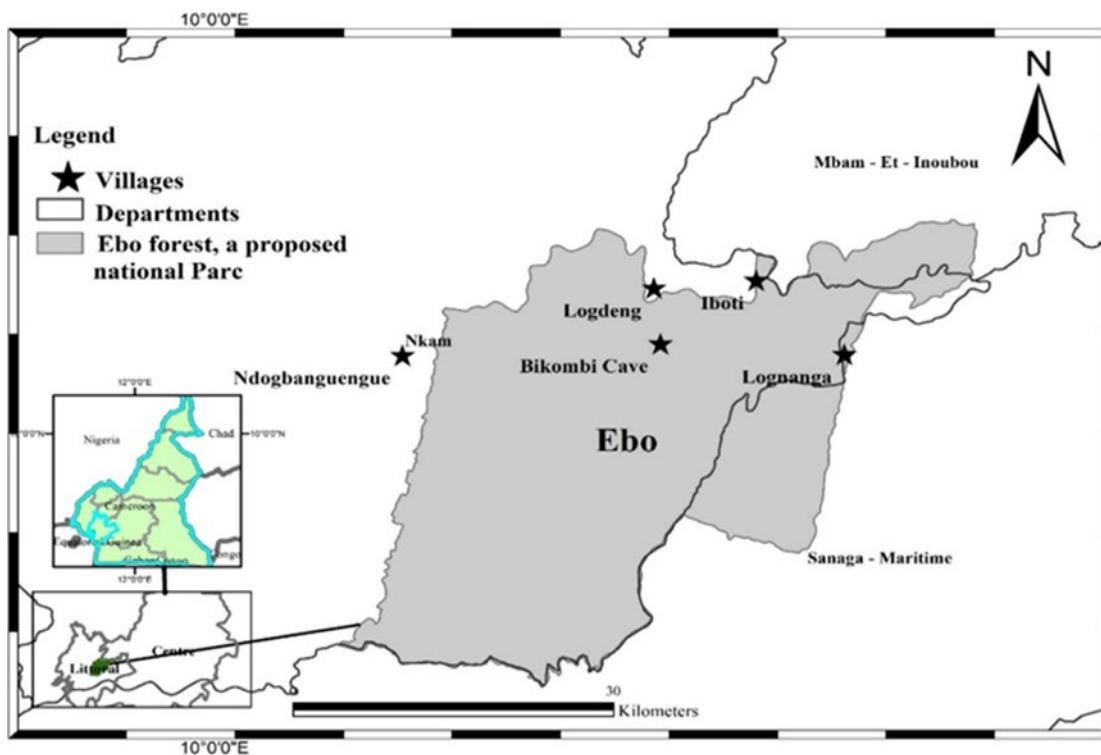


Figure 2 : Map showing villages where investigations have been carried out

The questionnaires consisted of 24 questions that were organised into five sections to : (1) referred to a personal and social characteristics of interviewees, (2) explore the general knowledge, diversity of taxa identified by the local people as well as their ecology, (3) examine the relations with bats and their uses, (4) understand the implication of bats for conservation in Ebo forest through local threats, hunting

activities and taxa occurring in the study area, and (4) evaluate the knowledge about zoonoses and risks of transmission to locals through their hunting activity and uses.

The first section comprised seven questions regarding the respondent's (1) age, (2) tribe, (3) gender, (4) marital status, (5) number of children, (6) educational level and (7) principal occupation (Table 1). The four questions in the second section focused on the (1) morphological description of bats by the interviewee as well as (2) the given name, (3) diet and (4) viewing location. In the third section we asked interviewees four questions related to (1) relations with bats, (2) local uses of bats trapped, (3) carcass processing and (4) species preferences for consumption. The fourth section consisted of six questions focused on (1) local threats, (2) hunting location, (3) trapping season, (4) species trapped, (5) types of traps and (6) bats taxa occurring in the area as well as their conservation status. The last section was focused on (1) knowledge and perceptions about some current diseases transmitted by bats, (2) risks to contract viruses through handling bats, and (3) behaviour following injuries due to bats scratch.

**Table 1:** Sociodemographics characteristics of respondents. For each question the total number of valid responses received is given in parentheses.

<b>Variables and response options</b>	<b>Category</b>	<b>No. of respondents (%)</b>
<b>Age years (79)</b>	15-20	01 (1.3)
	20-25	04 (5.1)
	25-30	04 (5.1)
	30-35	07 (8.9)
	35-40	10 (12.7)
	40-45	10 (12.7)
	45-50	09 (11.4)
	50-∞	33 (41.7)
<b>Tribe (79)</b>	Banen	66 (84)
	Bassa	10 (13)
	Others	03 (3)
<b>Gender (79)</b>	Female	14 (17.7)
	Male	65 (82.3)
<b>Marital status (74)</b>	Single	30 (40.5)
	Married	44 (59.5)
<b>No. of children (79)</b>	≤ 2	40 (50.6)
	3-5	22 (27.8)
	≥ 6	17 (21.6)
<b>Educational level (74)</b>	Primary	47 (63.5)
	Secondary	27 (36.5)
<b>Primary occupation (76)</b>	Farmer	61 (80.3)
	Carpenter	4 (5.3)
	Hunter	1 (1.3)
	Driver	2 (2.6)
	Trader	1 (1.3)
	Electrician	1 (1.3)
	Forester	1 (1.3)
	Car mechanic	1 (1.3)
	House maid	1 (1.3)
	Pastor	1 (1.3)



	Sawyer	1 (1.3)
	Technician	1 (1.3)

In the same framework, we performed an inventory of bats occurring in and around the forest (figure 1). The capture sites were located at Mopoun, Bekob, Njuma, Ndobassoni, Bikombi, Petit Bello'o, Grand Bello'o and Masseng (abandoned villages and hunters camps). Bats were collected during 14 nights in each site over the study period. Ground level mistnets were installed within flight paths identified and used frequently by bats. Nets were opened at dusk then closed at midnight (figure 3).



Figure 3 : Nets setting up

Captured bats were taken in the cloth bags for direct morphological identification in the field. Bats species tagged, have been released then after the skin samples have been collected for molecular analysis. However, molecular identifications have been carried out at the University of Douala aimed to confirm those obtained from the field using mitochondrial *Cytb* through MinION sequencer from Nanopore technologies.

## RESULTS

### KAP Study in the Ebo Forest

#### General knowledge about bat diversity and their ecology

General knowledge on bats diversity by respondents was influenced by socio-demographic values. Indeed, there is a significant difference between genders ( $P < 0.001$ ) and a significantly higher proportion of farmers than those with other occupations ( $P < 0.001$ ). We found that the majority (97.7%) of interviewees have a good knowledge of bats. Respondents have declared (73.4%) to know many bat species (mean  $2 \pm SD 2$  species) whose recognition characteristics were the size (71%)

or the colour (19%). In addition male showed a positive attitude about bats recognition using these description criterion (Table 2). However, there were three different names given to bats by 91% of respondents in their native language (Banen/Bassa respectively) including Benemb/ Nleem (54%) followed by Feukefeuck or Hipoupouka (26%) and Ikyon (20%). Benemb or Nleem and Feukefeuck or Hipoupouka were the names referring to large bats, belonging especially to the Pteropodidae family which were not reported as entering people's houses. Ikyon was a name given to smaller-sized bats, presumably insectivorous species, which were reported as roosting in houses or occasionally entering houses at night.

According to locals, bats were reported as feeding on fruits trees (82.3%) and particularly on fragments of guava (*Psidium guajava*), mangoes (*Mangifera indica*), cocoa (*Theobroma cacao*), pawpaw (*Carica papaya*) and banana (*Musa spp*). The respondents also reported that bats feeds on insects (9.7%) or lick the rock walls (19.4%) in the Bikombi cave. About viewing location, the most common responses were forest and particularly in the Bikombi cave (44 %) then trees mainly the sunshade tree (*Musanga cecropioides*) as the second most answers (29 %). In addition, bats were also observed in human constructions located at the populated and abandoned village (Bekob) such as under bridges, in the households and the farms (9% respectively). There is a positive influence on bat identifications using body size, colour, feeding and viewing location (Table 2). Our results also showed that, there is no influence of education level on bats knowledge (Table 3),

**Table 2:** GLM showing a positive influence on bats identifications using body size, colour, feeding and viewing location.

	<b>z value</b>	<b>Pr (&gt;  z )</b>
<b>Intercept</b>	<b>1.021</b>	<b>0.3070</b>
Body size	1.919	0.0549
Color	0.795	0.4268
Bats feed on insects, fruit trees and lick the rock wall	0.002	0.9981
I have seen bats on the trees, bridges, houses, farms, rivers, cave	0.007	0.9941

Significative codes: 0 '\*\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05

**Table 3:** GLM showing the effect educational level and sex on bats recognition.

	z value	Pr (>  z )
<b>Intercept</b>	<b>0.408</b>	<b>0.683</b>
Primary achievement	-0.106	0.915
Secondary achievement	-0.546	0.585
Sex Male	1.407	0.159

Significative codes: 0 '\*\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05

### Relationships with bats and local uses

To better understand the action of humans on bats in the study area, we identified the local use and activities that may influence the conservation of bat species in the Ebo forest. We found that 38.2% of respondents have confirmed having a particular relationship with bats and have justified this by hunting (75%) followed by traditional medicine (17.8%) or other than the two previously cited (7.2%). The majority of interviewees who reported hunting bats (44.3%) made it for bushmeat consumption (80.6%), trading (3.8%), because of their harmful nature (1.3%) or for other reasons

(3.8%, figure 4). However, many of the answers obtained (65.4%) show that bat meat is usually consumed after being burned and cleaned (98%) or after ordering an already cooked dish. Between genders, all the women who reported consuming bats prefer to clean them themselves rather than buying cooked dishes, while some men prefer to buy cooked dishes (5.9%). Most interviewees haven't a preference to species consumed. However, those reported that have one, prefer the species « Benemb » and mentioned as reason their tasty flesh, the high abundance of the species in their forest as well as their large size.

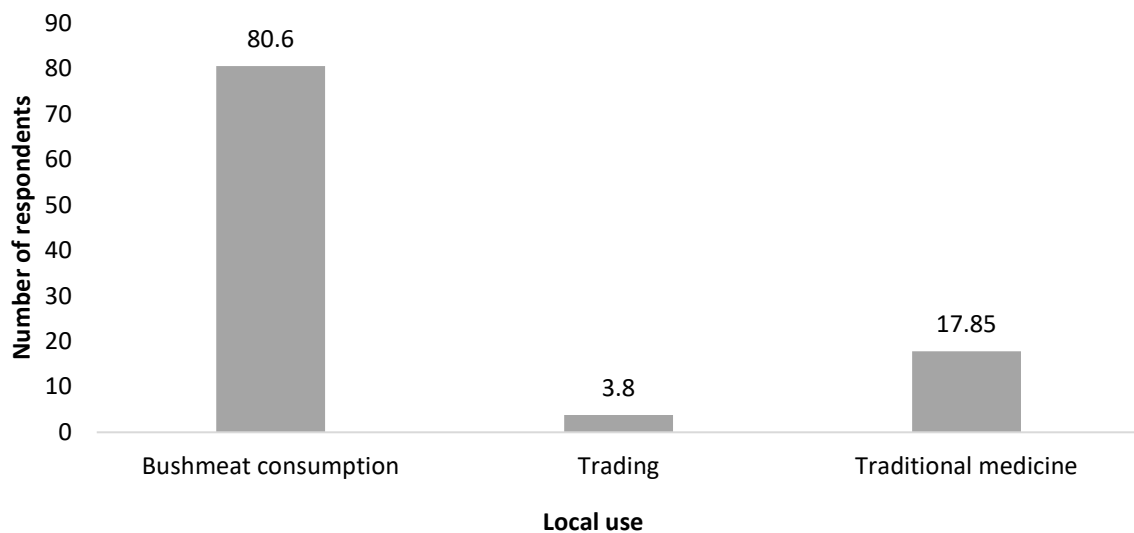


Figure 4 : Local use of bats trapped by locals

### Local threats, hunting activities and bats taxa occurring in the Ebo (implication for conservation)

Few people (30%) have reported bats as threatened. The figure 5 showed the main threats indicated by respondents. Hunting (80%) was the primary threat followed by agriculture (13%) and human intrusion (7%). These can be directly or indirectly disturb and threaten the bat population as well as their habitat.

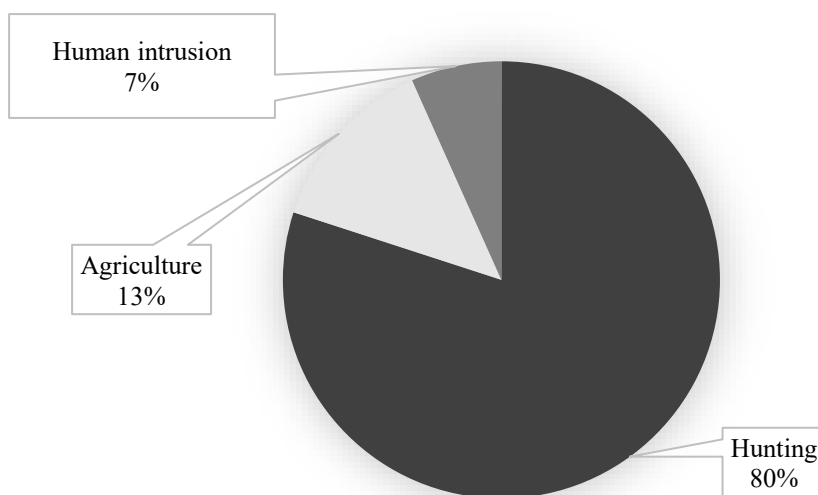


Figure 5 : Main threats affecting bats in Ebo forest



### Hunting activities

The hunting usually done at Bekombi cave (76.6%), was identified in this study as the main roosting site for several bats taxa and the preferred location for harvesting by villagers. Almost all respondents (61.5%) reported that higher number of captured bats was during the dry season (figure 6) and this, may reach at least 800 specimens after one trapping session. *Rousettus aegyptiacus* was the commonly trapped species locally and others were least concern by hunting. In terms of trapping methods, most of the respondents (74.2%) practice hunting with a firearm, followed by traditional rackets made from fishing nets (figure 7).

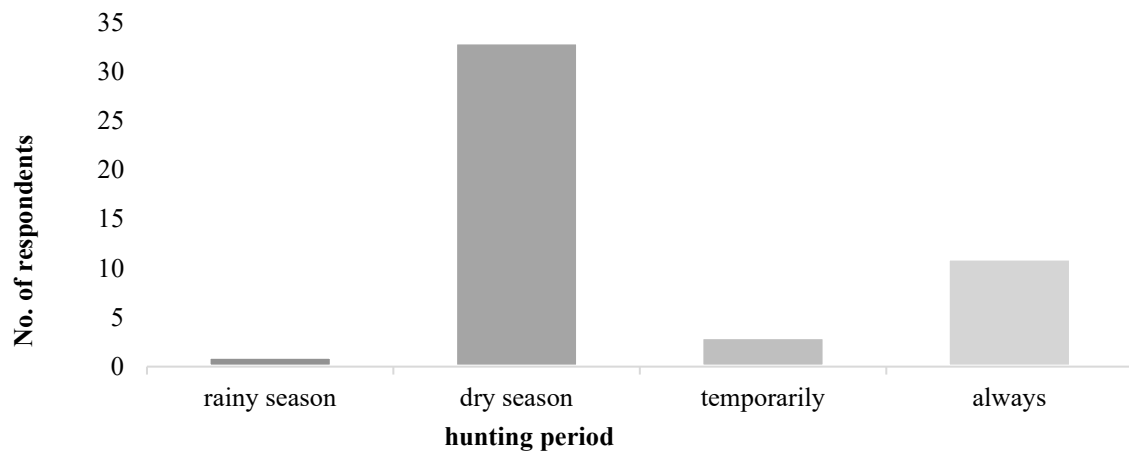


Figure 6: Hunting season preferred by hunters



Figure 7: Racket used by peoples during their hunting activity

### **Bats taxa occurring in the Ebo forest**

As part of this study, we captured 200 bats in and around the villages representing 14 species belonging to nine genera and four families (Table 3). All interviewees in the different study sites answered that amongst the bats trapped during our inventory, only the species *Rousettus aegyptiacus* was frequently observed and easily recognizable while others were never seen before. The most captured bats were Least Concern (LC) and only species *Glauconycteris cf. curryae* was listed as Data Deficient following the IUCN Red List. In general, the bat population trend presented in the four study sites would be increasing according to 68.6% of stakeholders due to their high reproduction rate or the big population size of the colony. About action towards bats conservation in the Ebo forest, respondents (66.6%) are not ready to keep bats by stopping to hunt. The reasons are the use of these latter as a food (73.5%) and they believe that species are not threatened (5.8%).

### **Knowledge about zoonoses and risks of transmission to locals**

In terms of diseases transmitted by bats to humans, villagers said that they have already heard about Ebola (97.5%) and COVID-19 (98.7%) and they mentioned no idea about others zoonotic viruses including Nipah, MERS, Marburg, SARS and rabies. Only 59.6% of interviewees stated that bats would be involved in the zoonotic transmission. In other hand, during hunting activities and bats handling and processing, protection measures are not observed by respondents overall. Indeed, people (100%) who declared burn and clean the meat themselves take a high risk of transmission of eventual diseases. However, some interviewees (41.1%) reported that, they have been scratched or bitten by bats. In case of injury, care were doing with barks (25%) or mixture of hot water and lemon (12.5%). Very few respondent (5.4%) are already fallen ill.

### **Activities explanation and awareness campaign with locals**

An awareness was carried in some villages included in our study. This activity combined with our investigations consisted in the explanation the morphology and ecological importance of bats and their potential risks to carry viruses.

Explaining to locals (left), a childrens (right), what's a « Bats » and their critical role playing in their forest and also the risks to contract zoonotic diseases throught bat meat consumption.



**Table 4:** Diversity and abundance of bats (with conservation status) occurring in and around study sites.

Family	Species identified	Common names	Conservation status (IUCN Red List)	Abundance	Recognition by locals / taxa hunted (yes or no)
Pteropodidae	<i>Epomops franqueti</i>	Franquet's Epauletted fruit Bat	LC	47	Yes, but not hunted
	<i>Hypsignathus monstrosus</i>	Hammer-headed fruit Bat	LC	2	No (never seen before)
	<i>Myonycteris angolensis</i>	Angolan Long-haired fruit Bat	LC	10	No (never seen before)
	<i>Megaloglossus woermanni</i>	Woermann's fruit Bat	LC	74	No (never seen before)
	<i>Myonycteris torquata</i>	Dwarf Fruit Bat	LC	9	No (never seen before)
	<i>Rousettus aegyptiacus</i>	Egyptian Fruit Bat	LC	22	Yes/ taxa frequently hunted
	<i>Scotonycteris zenkeri</i>	Zenker's Fruit Bat	LC	4	No (never seen before)
Vespertilionidae	<i>Glauconycteris curryae</i>	Curry's Bat	DD	2	No (never seen before)
Hipposideridae	<i>Hipposideros beatus</i>	Dwarf Leaf nosed Bat	LC	7	No (never seen before)
	<i>Hipposideros cyclops</i>	Cyclops Leaf-nosed Bat	LC	3	No (never seen before)
	<i>Hipposideros gigas</i>	Commerson's round leaf bat	LC	1	No (never seen before)
	<i>Hipposideros ruber</i>	Red Leaf-nosed Bat	LC	13	No (never seen before)
Rhinolophidae	<i>Rhinolophus alcyone</i>	Halcyon Horseshoe Bat	LC	5	No (never seen before)
	<i>Rhinolophus landeri</i>	Lander's Horseshoe Bat	LC	1	No (never seen before)

DD: Data deficient; LC: Least concern



### **Future plans**

- Publish these first results (being submitted) in the scientific review « *Ethnobiology and conservation* ».
- Make an taxonomic clarification of species combining morphological and molecular approaches.
- Compare the bats species richness, composition and species abundance between habitat types (primary forest, secondary forest, cocoa farms and surrounded human settlement).

### **ACKNOWLEDGEMENTS**

I sincerely thanks the Rufford Foundation, who entirely funded this project that allow me to increase my experience in field. I'm also thanks the IDEA WILD through providing to us some field materials to collect our data. I thanks particularly Dr Nicolas POLLET from University of Paris- Saclay, during a training session « GENBARQUE » between November-December 2021 to perform our molecular analysis. I sincerely thank Ebo forest population for their availability, and support.

### **Appendix 1 : Some bats occuring in the Ebo forest**



***Hipposideros cyclops***



*Rousettus aegyptiacus*



*Scotonycteris zenkeri*



*Rhinolophus landeri*





*Lyssonycteris angolensis*



*Hypsignathus monstrosus* (male)



*Hipposideros beatus*



*Hipposideros ruber*



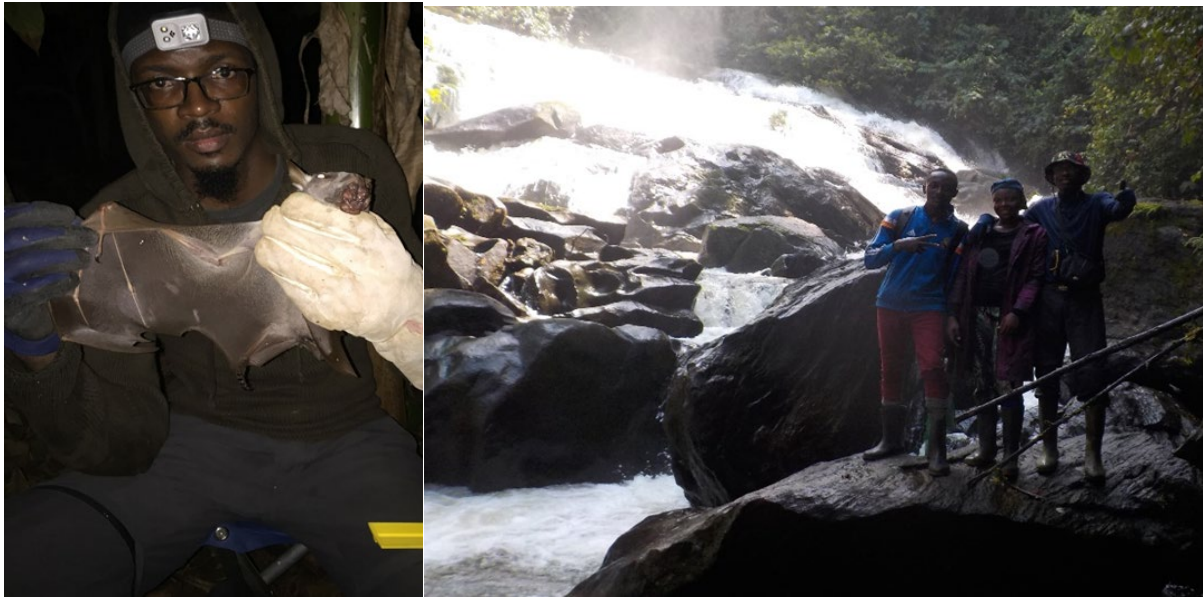
**Appendix 2 : Some pictures from the field**



**Field identification station**



**Field trip to Njuma (Ebo forest)**



**Handling bat (left) and their field team (right)**

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